United States
Department of
Agriculture

Forest Service

**Intermountain
Forest and Range
Experiment Station
Ogden, UT 84401**

Research Note
INT-350

March 1985

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ACKNOWLEDGMENT

Authors acknowledge Richard Bjerregaard, representative of Eli Lilly and Company, for his assistance and for materials furnished for this study.

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ABSTRACT

Application of pelleted tebuthiuron initially reduced numbers of broom snakeweed plants and suppressed yields of Fairway wheatgrass. Effects of herbicide residues in reducing broom snakeweed plants were still observed after 4 years. However, erratic control and ease of plant reestablishment suggests that tebuthiuron is not an effective control of broom snakeweed in the Intermountain area.

KEYWORDS: tebuthiuron, herbicide, broom snakeweed, *Xanthocephalum sarothrae*

Broom snakeweed (*Xanthocephalum sarothrae* [Pursh] Shinners) is a common half-shrub in the Western United States. It is a short-lived perennial that often aggressively increases in disturbed areas. However, its populations are cyclic and are therefore not reliable indicators of overgrazing (Jameson 1970).

Broom snakeweed can strongly suppress production of warm-season short grasses (Jameson 1966; Ueckert 1979) and may be toxic to livestock (Sperry and others 1964). Possibly the only positive attribute is its value as a food item for such wildlife as scaled quail (*Callipepla squamata*) (Davis and others 1975) and pronghorn (*Antilocapra americana*) (Couey 1946; Smith and Beale 1980).

The control of broom snakeweed with herbicides has been erratic. However, a number of chemicals have been effective (Johnsen 1966; Sosebee and others 1982). Tebuthiuron (N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N'-dimethylurea)—applied as a wettable powder at 0.5 lb/acre (0.6 kg/ha) active ingredient (a.i.) or in pelleted form at 0.45 lb/acre (0.5 kg/ha) a.i.—controlled broom snakeweed in Texas (Sosebee and others 1979; Jacoby and others 1982). Also, 2 lb/acre (2.2 kg/ha) or more of pelleted tebuthiuron has controlled broom snakeweed in Wyoming and Arizona (Alley and Humburg 1978; Johnsen and Madrigal 1979).

This study was undertaken to evaluate the effectiveness of pelleted tebuthiuron in controlling broom snakeweed on a central Utah site.

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METHODS

The test site is in the northeastern portion of Millard County, UT, on the Church Hills area of the Fishlake National Forest. Annual precipitation on the study area averages 14 inches (36 cm). Precipitation falls predominantly in the cool portion of the year. The months of June through September each average less than 1 inch (2.5 cm) of rainfall. Weather records from nearby communities of Oak City and Scipio show that the 4 years after herbicide application (fall 1979) were wetter than usual. Water year 1980 (October through September) was 54 percent above the long-term mean, 1981 was 1 percent above the mean, 1982 was 62 percent above the mean, and 1983 was 57 percent above the mean. Surface soil is a gravelly, very fine sandy loam developed on short alluvial fans originating from the south end of the Canyon Mountains. Quartzite and some limestone are the parent rocks.

At the time of the study, the predominant plants on the study site were Fairway wheatgrass (*Agropyron cristatum* [L.] Gaertn.), cheatgrass brome (*Bromus tectorum* L.), bulbous bluegrass (*Poa bulbosa* L.), bur buttercup (*Ranunculus testiculatus* Crantz), mountain big sagebrush (*Artemisia tridentata vaseyana* [Rydb.] Beetle), and broom snakeweed.

Tebuthiuron pellets were applied aerially (October 1979) on randomly selected parallel strips 168 feet (51 m) wide, perpendicularly across three gently sloping ridgetops containing the broom snakeweed communities. Application rates of 10 percent a.i. pellets were 0, 0.6, 0.9, and 1.2 lb/acre (0, 0.6, 1.0, and 1.3 kg/ha) a.i., which resulted in 1.1, 1.6, and 2.2 pellets per square foot of soil surface (12, 17, and 24 pellets per square meter) (Elanco 1983). The rates were each replicated two times for a total of eight strips. A randomized block experimental design was used. Each strip was sampled by two clusters of four 108-ft^2 (10-m^2) permanent circular plots, wherein counts of live broom snakeweed plants were made. Herbage production was determined on 9.6-ft^2 (0.9-m^2) plots centered within each of the 108-ft^2 plots by estimating wet weight. Herbage on every fifth plot was clipped, ovendried, and weighed as a basis for calculating dry weight from wet weight.

Vegetation evaluations were conducted in the growing seasons of 1980, 1981, 1982, and 1983. All observations and measurements were completed by midsummer each year.

RESULTS AND DISCUSSION

Two after-application results were monitored. One was the degree of control of broom snakeweed. The other was the subsequent response of other plants.

Control of Broom Snakeweed

Control of broom snakeweed by pelleted tebuthiuron was erratic (table 1). The first growing season after application, the two heaviest rates (0.9 and 1.2 lb/acre) significantly reduced the number of snakeweed plants and a nonsignificant reduction appeared to occur under the lightest rate. However, the second year a large increase in plants occurred due to establishment of new seedlings in all strips including strips with no herbicide.

Table 1.—Number of broom snakeweed plants per 108 ft^2 by year and tebuthiuron application rate

	Active ingredient (lb/acre)			
Year	**0**	**0.6**	**0.9**	**1.2**
1980	22a[1]	12ab	8b	8b
1981	139a	345a	106a	148a
1982	167a	160a	62a	62a
1983	73a	37ab	12b	16b

[1]Values followed by different letters within years are significantly different at $P<0.05$.

Although there were no significant differences in plant numbers, the largest apparent increase occurred in the strips with the light application rate. Presumably, this was a result of a combination of reduction in plant competition due to herbicide response during the first growing season and a lower portion of the total soil surface directly affected by tebuthiuron residues. Thus, more surface area could be available for snakeweed reestablishment in light application strips than in strips treated at the heavier rates or in untreated strips containing competing mature plants. A similar response by cheatgrass brome and by broom snakeweed was observed at low pellet densities following application of tebuthiuron pellets to Gambel oak (*Quercus gambelii* Nutt.) stands (Clary and others 1984).

In the third growing season (1982), the broom snakeweed suffered roughly 50 percent mortality in the treated strips. This may have occurred because the expanding seedling root systems encountered additional tebuthiuron soil residues. In the fourth growing season (1983), considerable natural mortality occurred as evidenced by the reduction in snakeweed plants in both treated and untreated strips. Significantly lower amounts of snakeweed in the heavy treatment strips in 1983 suggest that tebuthiuron residues were still affecting plant populations, and that 4 years after application the residues have resulted in fewer broom snakeweed plants even though a flush of reestablishment occurred in the posttreatment period.

The cyclic nature of broom snakeweed populations described by Jameson (1970) was a factor in the results of this study. Wide fluctuations in plant numbers on treated and untreated strips testify to the high rates of seedling establishment and high rates of natural mortality to be expected in these populations. Such fluctuations blur the evaluation of treatment response and cast some doubt on the long-term effectiveness of broom snakeweed treatment by pelleted herbicide. The wettable powder formulation of tebuthiuron may be more effective against broom snakeweed (Sosebee and others 1979) as it would leave a much smaller portion of the soil surface unaffected by herbicide. However, pelleted tebuthiuron was effective in controlling broom snakeweed in Texas (Jacoby and others 1982). Part of the apparent difference in response compared to the current study may have been related to the difference in seasonal distribution of precipitation. Areas such as west Texas and New Mexico, which have predominantly summer precipitation, may also have greater broom snakeweed root activity in the surface soil layers where the herbicide residues are concentrated (Richard Bjerregaard, personal communication, 1984). Higher rates of pelleted tebuthiuron (≥ 2 lb/acre or 2.2 kg/ha) in the current study would probably have provided more effective control (Alley and Humburg 1978; Johnsen and Madrigal 1979), but rates that high have severe effects on herbaceous vegetation in the area (Clary and others, 1985).

A potential user should keep in mind that, in general, tebuthiuron effectiveness against both target and nontarget plant species increases as soil texture becomes more sandy and decreases as clay and organic matter increase (Duncan and Scifres 1983). Therefore, application rates should be adjusted with environmental considerations such as soils and precipitation in mind.

Response of Plant Production

Total plant production (herbage plus leaf and twig growth of shrubs) on the treated strips was not significantly different ($P>0.05$) from the control strip in the second, third, or fourth growing seasons after herbicide application (total production was not determined the first growing season) (table 2). There appeared to be some increase in annual grasses in the herbicide-treated area relative to the untreated area in the third and fourth seasons such as occurred on a juniper control study site (Clary and others, 1985), but the trend was not significant ($P>0.05$). Perennial grasses, principally Fairway wheatgrass, were suppressed by the herbicide the first growing season ($P<0.05$) but exhibited no significant effect in succeeding years. Forbs occurred in such small amounts on the study area that statistical detection of change was not feasible.

The most prominent change was a reduction in production of shrubs. Total shrub production was significantly reduced ($P<0.05$) by all herbicide application rates in 1981 and 1983 (no shrub production data were taken in 1980). The primary shrub species, broom snakeweed and mountain big sagebrush, were strongly reduced by the herbicide (table 3). However, the highly irregular distribution of plants on the study area made statistical detection of treatment effects difficult. Erratic distribution of large numbers of newly established broom snakeweed seedlings (table 1) resulted in no significant

Table 2.—Production (lb/acre) by plant group, year, and tebuthiuron application rate

	Active ingredient (lb/acre)			
Year	0	0.6	0.9	1.2
Annual grass				
1980	4a[1]	8a	6a	7a
1981	0a	36a	20a	26a
1982	21a	148a	180a	203a
1983	83a	294a	215a	137a
Perennial grass				
1980	201a	106b	73b	58b
1981	188a	147a	105a	62a
1982	227a	358a	240a	202a
1983	441a	348a	252a	295a
Forbs				
1980	4a	2a	2a	4a
1981	0a	0a	0a	0a
1982	11a	1a	4a	4a
1983	8a	4a	3a	5a
Shrubs				
1980	—	—	—	—
1981	130a	26b	14b	9b
1982	98a	81a	26a	10a
1983	83a	21b	4b	1b
Total				
1980	—	—	—	—
1981	318a	209a	139a	97a
1982	357a	588a	450a	419a
1983	615a	667a	474a	438a

[1]Values followed by different letters within lines are significantly different at $P<0.05$.

($P>0.05$) shrub differences among treatments in 1982, although trends among treatment means were similar to those of 1981 and 1983. By 1983, the herbicide residues had apparently increased the mortality of the developing snakeweed plants (expanding root systems encountering herbicide pellet residues), so significant differences were again present in 1983.

Table 3.—Production (lb/acre) by principal shrub species, year, and tebuthiuron application rate

	Active ingredient (lb/acre)			
Year	0	0.6	0.9	1.2
Mountain big sagebrush				
1980	—	—	—	—
1981	28aa[1]	0aa	0aa	0aa
1982	53aa	6aa	0aa	0aa
1983	62aa	14bb	0bb	0bb
Broom snakeweed				
1980	—	—	—	—
1981	102a[2]	24b	14b	9b
1982	45aa	74aa	25aa	8aa
1983	20a	7b	4b	1b

[1]Values followed by different double letters within lines are significantly different at $P<0.10$.
[2]Values followed by different single letters within lines are significantly different at $P<0.05$.

General conclusions of the authors based on statistically significant and nonsignificant data trends and on general observation of the treatment areas are:

1. Pelleted tebuthiuron will likely reduce established broom snakeweed stands. But at herbicide application rates up to 1.2 lb/acre a.i., reestablishment of seedlings on the portions of soil surface without herbicide residue may initially compensate for the loss.
2. The cyclic nature of broom snakeweed populations may result in rapid reestablishment after herbicide treatment, or natural mortality may result in regularly occurring reductions in snakeweed populations with or without herbicide.
3. Perennial grasses, principally Fairway wheatgrass, were initially reduced as a result of herbicide application, and after several years annual grasses became more visually apparent on treated sites.
4. There is questionable benefit in using the pelleted form of tebuthiuron for control of broom snakeweed in the Intermountain area for situations similar to the test site.

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S. GOVERNMENT PRINTING OFFICE: 1985-0-576-040/10530

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